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(54) **SETTING TOOL, ANCHORING AND SEALING DEVICE AND SYSTEM**

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E21B 33/134	(2006.01)
E21B 23/01	(2006.01)
E21B 33/12	(2006.01)

(52) **U.S. Cl.**

CPC ***E21B 33/128*** (2013.01); ***E21B 23/01*** (2013.01); ***E21B 33/12*** (2013.01); ***E21B 33/129*** (2013.01); ***E21B 33/134*** (2013.01); ***E21B 43/26*** (2013.01)

(58) **Field of Classification Search**

CPC ... E21B 33/1285; E21B 33/128; E21B 23/06; E21B 33/12; E21B 33/34; E21B 33/122; E21B 23/01; E21B 33/134; E21B 33/129; E21B 43/26

USPC 166/387, 120, 179, 118, 206

See application file for complete search history.

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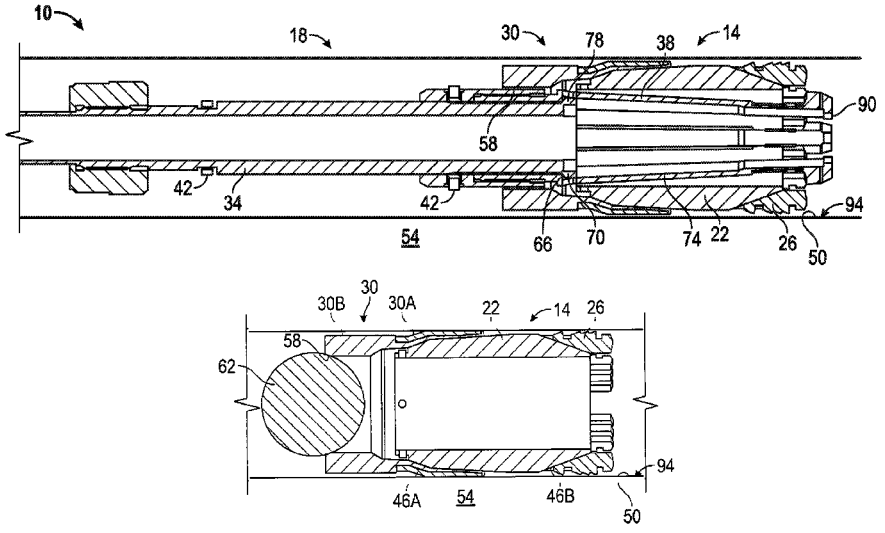
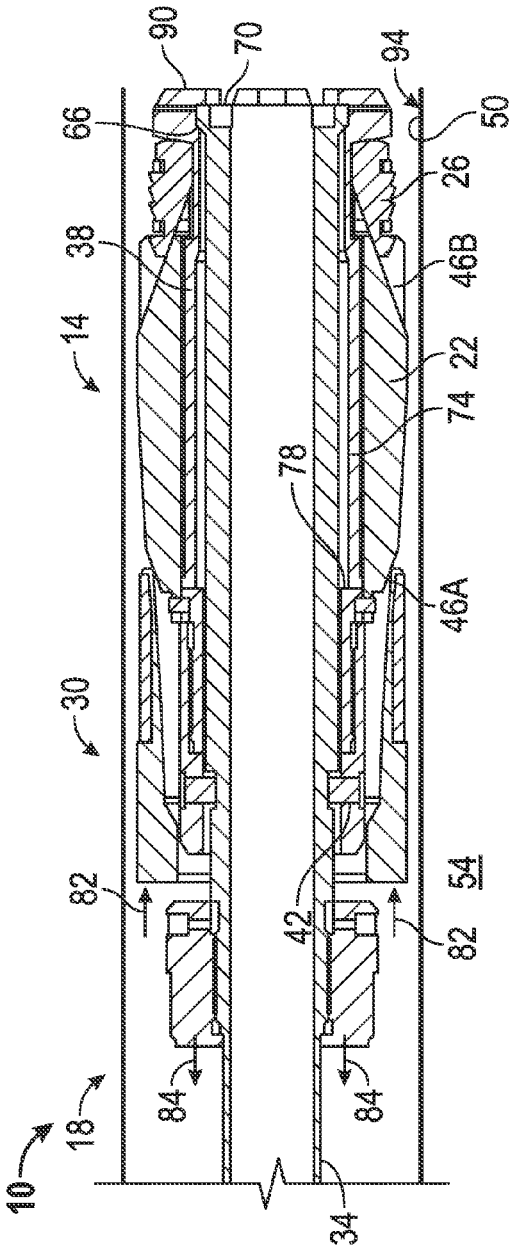
(57) **ABSTRACT**

An anchoring and sealing device includes at least one slip, a seal and a tubular in operable communication with the at least one slip and the seal. The anchoring and sealing device is configured to cause radial movement of the at least one slip into anchoring engagement with a structure and to cause radial movement of the seal into sealing engagement with the structure in response to longitudinal compression of the anchoring and sealing device. The anchoring and sealing device is also configured to maintain anchoring and sealing engagement with the structure without additional components remaining in contact therewith.

18 Claims, 2 Drawing Sheets

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70
94
50
66
26
38
46B
14
22
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78
46A
30
82
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42
82
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84
18
10
34

FIG. 1

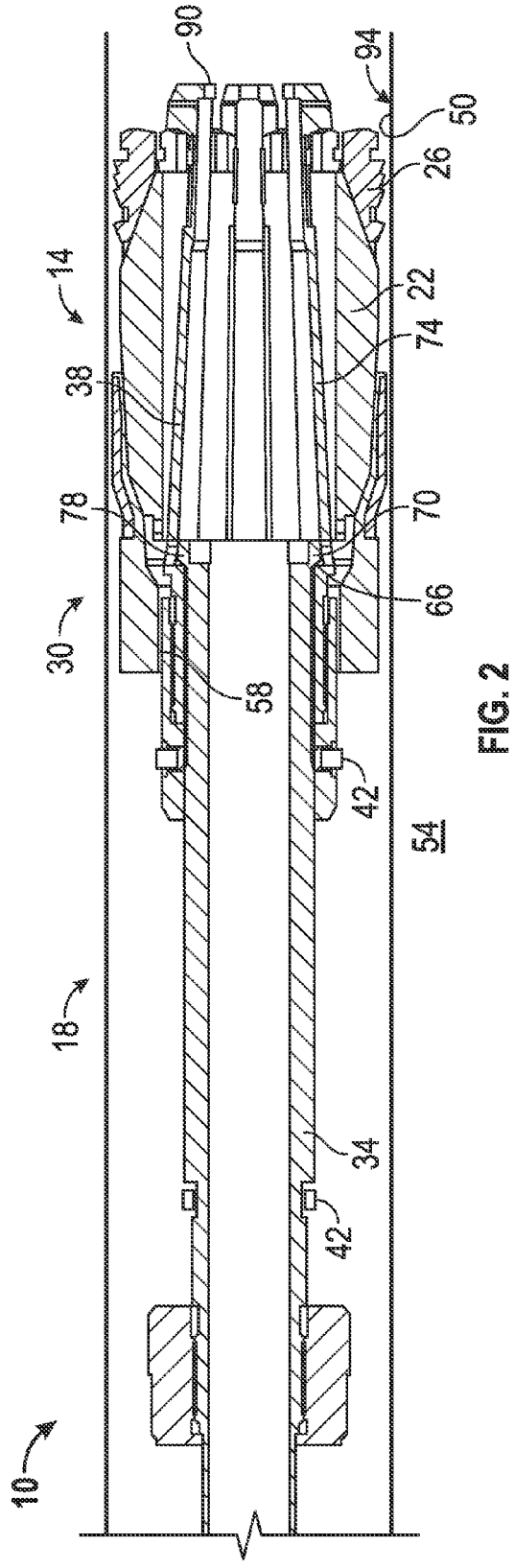
90
94
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FIG. 2

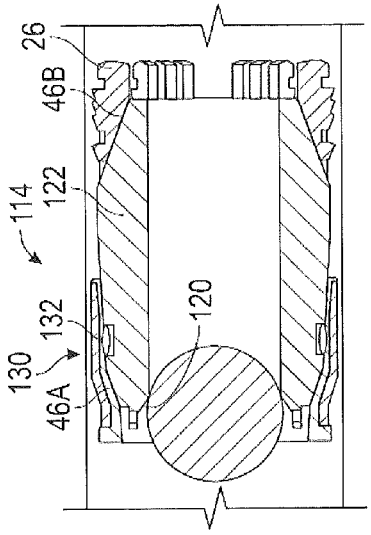

FIG. 4

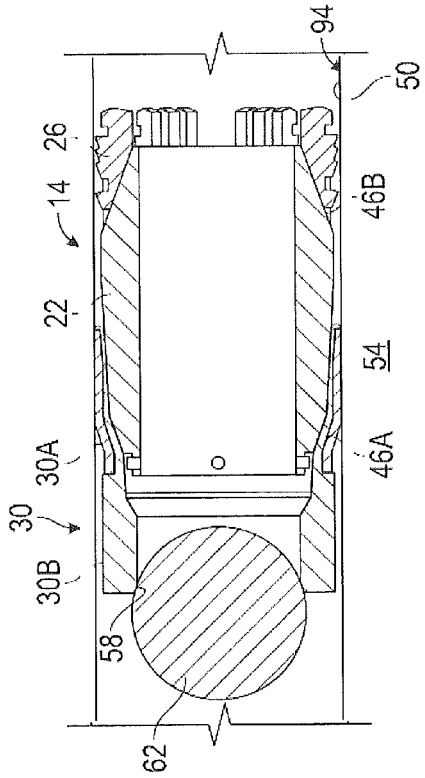

FIG. 3

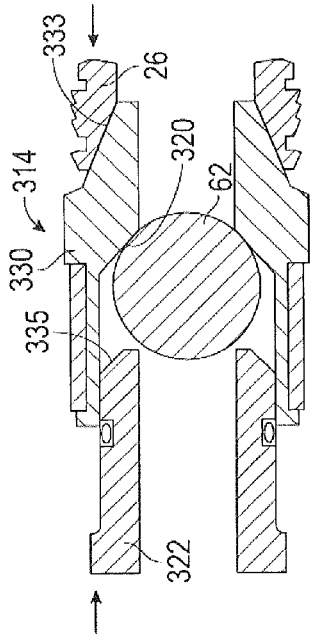

FIG. 6

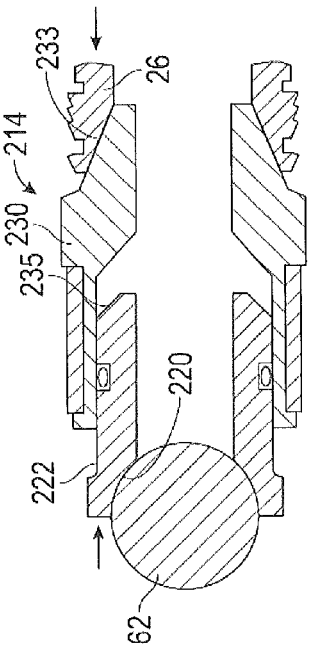

FIG. 5

SETTING TOOL, ANCHORING AND SEALING DEVICE AND SYSTEM

BACKGROUND

Tubular systems, such as those used in the completion and carbon dioxide sequestration industries often employ anchors to positionally fix one tubular to another tubular, as well as seals to seal the tubulars to one another. Although existing anchoring and sealing tools and systems for setting such tools serve the functions for which they are intended, the industry is always receptive to new systems and methods for anchoring and sealing tubulars.

BRIEF DESCRIPTION

Disclosed herein is an anchoring and sealing device. The device includes at least one slip, a seal and a tubular in operable communication with the at least one slip and the seal. The anchoring and sealing device is configured to cause radial movement of the at least one slip into anchoring engagement with a structure and to cause radial movement of the seal into sealing engagement with the structure in response to longitudinal compression of the anchoring and sealing device. The anchoring and sealing device is also configured to maintain anchoring and sealing engagement with the structure without additional components remaining in contact therewith.

Further disclosed herein is an anchoring and sealing system. The system includes at least one slip, a seal, and a tubular in operable communication with the at least one slip and the seal. The anchoring and sealing device is configured to cause radial movement of the at least one slip into anchoring engagement with a structure and to cause radial movement of the seal into sealing engagement with the structure in response to longitudinal compression of the anchoring and sealing device. A setting tool is configured to set the at least one slip into anchoring engagement with the structure and the seal into sealing engagement with the structure. The setting tool includes, a mandrel, a collet slidably engaged with the mandrel between a first position and a second position, and fingers of the collet are radially supported by the mandrel when in the first position and unsupported radially when in the second position. A releasable member is in operable communication with the mandrel and the collet and is configured to maintain the collet in the first position until forces greater than forces needed to set the at least one slip and the seal are attained.

Further disclosed herein is a setting tool. The setting tool includes a mandrel, a collet slidably engaged about the mandrel having radially deformable fingers that are prevented from radially deforming when the collet is in a first position relative to the mandrel and are allowed to radially deform when the collet is in a second position relative to the mandrel. The radially deformable fingers are engagable with a settable tool when in the first position and disengagable from the settable tool when in the second position and a release member releasably fixes the collet to the mandrel in the first position until release thereof, the release member is configured to release at loads greater than loads needed to set the settable tool.

BRIEF DESCRIPTION OF THE DRAWINGS

The following descriptions should not be considered limiting in any way. With reference to the accompanying drawings, like elements are numbered alike:

FIG. **1** depicts a cross sectional view of an anchoring and sealing system disclosed herein in a run-in position;

FIG. **2** depicts a cross sectional view of the anchoring and sealing system of FIG. **1** in a partially set position;

FIG. **3** depicts a cross sectional view of an anchoring and sealing device disclosed herein;

FIG. **4** depicts a cross sectional view of an alternate embodiment of the anchoring and sealing device disclosed herein;

FIG. **5** depicts a cross sectional view of another alternate embodiment of the anchoring and sealing device disclosed herein; and

FIG. **6** depicts a cross sectional view of yet another alternate embodiment of the anchoring and sealing device disclosed herein.

DETAILED DESCRIPTION

A detailed description of one or more embodiments of the disclosed apparatus and method are presented herein by way of exemplification and not limitation with reference to the Figures.

Referring to FIGS. **1**, **2** and **3** an anchoring and sealing system disclosed herein is illustrated at **10**. The system **10** includes a settable tool **14**, illustrated herein as an anchoring and setting device that is settable by a setting tool **18**. The settable tool **14** has a tubular **22**, at least one slip **26** (with a plurality of slips **26** being shown in the embodiment illustrated herein), and a seal **30**, and the setting tool **18** has a mandrel **34**, a collet **38** and a release member **42**. Both the slips **26** and the seal **30** are radially expandable upon longitudinal movement against the tubular **22**. Two frustoconical surfaces **46**A, **46**B on the tubular **22** facilitate the radial expansion of the slips **26** and the seal **30** when moved longitudinally thereagainst. A structure **50**, shown herein as a borehole in earth formation **54**, is contactable by both the slips **26** and the seal **30** when they are radially expanded. Such radial expansion causes the slips **26** to anchor or longitudinally fix the settable tool **14** to the structure **50**, while the seal **30** seals the tubular **22** to the structure **50** when radially expanded. The settable tool **14** is configured so that once set within the structure **50** no additional components beyond the tubular **22**, the slips **26** and the seal **30** are needed for the settable tool **14** to remain set within the structure **50** as is illustrated in FIG. **3**.

The settable tool **14** is settable in the structure **50** by longitudinal compression thereof. Angles of the frustoconical surface **46**A, **46**B as well as dimensions, materials and surface finishes of the tubular **22**, the slips **26** and the seal **30** are selectable to cause either the slips **26** or the seal **30** to be set prior to the setting of the other of the slips **26** and the seal **30**. In some applications it may be desirable to have the seal **30** set first so as not to cause damage to the seal **30** due to movement relative to structure **50** that could occur if the slips **26** are set before the seal **30** is set. The settable tool **14** illustrated in the embodiment of the Figures herein is a packer-type tool such as a frac plug, for example, that includes a seat **58** on the seal **30** that is sealingly receptive to a plug **62** such as a ball, for example, that is run thereagainst. The frac plug **14** allows the earth formation **54** to be fractured via pressure built against the plug **62** when seated at the seat **58**. Forces against the plug **62** while seated also urge the seal **30** to wedge between the tubular **22** and the structure **50** increasing sealing integrity thereof. The frag plug **14** has a large radial opening therethrough for production of fluid therethrough, for example. This large radial opening is in part possible because the frac plug **14** doesn't need any additional components to extend

longitudinally through the tubular **22** to maintain it in the set condition. The angles of the frustoconical surface **46**A, **46**B as well as dimensions, materials and surface finishes of the tubular **22**, the slips **26** and the seal **30** are also selectable to cause the settable tool **14** to remain set within the structure **50** after the setting tool **18** has been removed. These parameters result in frictional engagement and a wedging action of the slips **26** and the seal **30** between the tubular **22** and the structure **50**.

The setting tool **18** is configured to set the settable tool **14** within the structure **50**. The collet **38** in the illustrated embodiment is coaxial with the mandrel **34** and is longitudinally movable relative to the mandrel **34** after the release member **42** has been released. Prior to release of the release member **42** the collet **38** is fixedly attached to the mandrel **34**. Shoulder **66** on an end **70** of the mandrel **34** is longitudinally aligned with fingers **74** of the collet **38** thereby radially supporting and preventing the fingers **74** from flexing radially inwardly. This support maintains the fingers **74** in radial positions that overlap with the slips **26** thereby assuring that the fingers **74** urge the slips **26** against the frustoconical surface **46**B in response to movement of the collet **38** relative to the tubular **22** to set the slips **26**. This urging load is carried by the release member **42** that maintains the collet **38** in a first position (FIG. **1**) relative to the mandrel **34** until the release load of the release member **42** is attained. Once attained the release member **42** releases thereby allowing the mandrel **34** to move relative to the collet **38** to the second position (FIG. **2**). In the second position the fingers **74** are no longer radially supported by the mandrel **34** thereby allowing them to deform radially inwardly until they clear the slips **26** and can be pulled fully through the tubular **22** and withdrawn from all contact with the settable tool **14** (FIG. **3**). During withdrawal of the collet **38** from the tubular **22** the shoulder **66** contacts a shoulder **78** on the collet **38** (this defines the second position) thereby causing the collet **38** to be withdrawn with the mandrel **34**.

The force required to set the seal **30** into sealing engagement with the structure **50** can be set to a force less than that required to release the release member **42** to assure that the seal **30** fully sets prior to release of the release member **42**. As mentioned above it may also be desirable to select a set force for the seal **30** that is less than that of the slips **26** to prevent relative motion between the seal **30** and the structure **50** during setting thereof. This force relationship can also be beneficial in assuring that the forces on the release member **42** are fully transferred to the setting of the seal **30** and are not absorbed by the slips **26** being engaged with the structure **50** which, if allowed to occur, could prevent full setting of the seal **30**.

The seal **30** can be a single piece of a single material such as metal, or polymeric, for example. Alternately, the seal **30** can have two or more portions. The illustrated embodiment of the seal **30** includes a first portion **30**A that is polymeric and a second portion **30**B that is metal. The first portion **30**A provides malleability to improve sealing against any imperfections in walls **94** of the structure **50**. The second portion **30**B provides stiffness to assure that longitudinal forces thereagainst cause the second portion **30**B to slide along the frustoconical surface **46**A as both the second portion **30**B and the first portion **30**A expand radially. Additionally, the second portion **30**B can have the seat **58** thereon that is seatingly engagable with the plug **62** as discussed above.

Although not detailed in the Figures the setting tool **18** includes a portion that pushes against the seal **30** in the direction of arrows **82** in FIG. **1** while the mandrel **34** is moved in the direction of arrows **84** thereby providing longitudinal compression to the settable tool **14**.

The end **70** of the mandrel **34** also abuts against protrusions **90** that project radially inwardly from the fingers **74**. This assures that any loads imparted on the fingers **74** such as those due to inadvertent contact with the walls **94** while the system **10** is being run into the structure **50** will be absorbed through the mandrel **34**. Such a configuration prevents these loads from being absorbed by the release member **42** that could result in undesirable and premature release or damage to the release member **42**.

Referring to FIG. **4**, an alternate embodiment of a settable tool illustrated herein as an anchoring and sealing device is shown at **114**. The settable tool **114** is similar to the settable tool **14** described above and as such like elements are identified with the same reference characters and are not again described in detail hereunder. The settable tool **114** differs from the settable tool **14** in that a seat **120** receptive to the plug **62** is located on a tubular **122** of the settable tool **114** and is not on a seal **130** as is the case in the settable tool **14**. Greater loads may be supportable by the tubular **122** of the settable tool **114** than by the relatively thin walled second portion **30**B of the seal **30** of the tool **14** that is designed to radially expand as it stretches over the first frustoconical surface **46**A. These greater loads urge the tubular **122** toward the slips **26** thereby improving the anchoring provided by the slips **26** engaged with the second frustoconical surface **46**B. An optional seal **132** may be used to slidable seal the dynamic seal **130** to the tubular **122** to prevent leakage therebetween since pressure built upstream of the plug **62** is provided to an interface between these parts unlike in the tool **14**.

Referring to FIG. **5**, an alternate embodiment of a settable tool illustrated herein as an anchoring and sealing device is shown at **214**. The settable tool **214** is similar to the settable tool **14** described above and as such like elements are identified with the same reference characters and are not again described in detail hereunder. The settable tool **214** differs from the settable tool **14** in the location and relative position of a tubular **222** relative to a seal **230**. In the tool **214** the seal **230** is longitudinally between the slips **26** and the tubular **222**. The seal **230** has a frustoconical portion **233** that engages with the slips **26** and the tubular **222** has a frustoconical portion **235** that engages with the seal **230**. A seat **220** receptive to the plug **62** is located on the tubular **222** and as such provides additional anchor engaging forces to the slips **26** in response to pressure on the plug **62** seated thereagainst.

Referring to FIG. **6**, another alternate embodiment of a settable tool illustrated herein as an anchoring and sealing device is shown at **314**. The settable tool **314** is similar to the settable tool **14** described above and as such like elements are identified with the same reference characters and are not again described in detail hereunder. The settable tool **314** differs from the settable tool **14** in the location and relative position of a tubular **322** relative to a seal **330**. In the tool **314** the seal **330** is longitudinally between the slips **26** and the tubular **322**. The seal **330** has a frustoconical portion **333** that engages with the slips **26** and the tubular **322** has a frustoconical portion **335** that engages with the seal **330**. A seat **320** receptive to the plug **62** is located below the sealing surface (rightward in FIG. **6**) on the seal **330** and as such prevents overloading the relatively thin walled portion of seal **330** in response to pressure on the plug **62**.

While the invention has been described with reference to an exemplary embodiment or embodiments, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the scope of the invention. In addi-

tion, many modifications may be made to adapt a particular situation or material to the teachings of the invention without departing from the essential scope thereof. Therefore, it is intended that the invention not be limited to the particular embodiment disclosed as the best mode contemplated for carrying out this invention, but that the invention will include all embodiments falling within the scope of the claims. Also, in the drawings and the description, there have been disclosed exemplary embodiments of the invention and, although specific terms may have been employed, they are unless otherwise stated used in a generic and descriptive sense only and not for purposes of limitation, the scope of the invention therefore not being so limited. Moreover, the use of the terms first, second, etc. do not denote any order or importance, but rather the terms first, second, etc. are used to distinguish one element from another. Furthermore, the use of the terms a, an, etc. do not denote a limitation of quantity, but rather denote the presence of at least one of the referenced item.

What is claimed:

1. An anchoring and sealing device comprising:

at least one slip;

a seal; and

a tubular in operable communication with the at least one slip and the seal the anchoring and sealing device being configured to cause radial movement of the at least one slip into anchoring engagement with a structure and to cause radial movement of the seal into sealing engagement with the structure in response to longitudinal compression of the anchoring and sealing device and to maintain anchoring and sealing engagement with the structure without additional components except for the at least one slip, the seal and the tubular, the anchoring and sealing device including at least one seat receptive to a plug run thereagainst wherein pressure built against a plug seat at the at least one seat increases at least one of sealing forces between the seal and the structure and anchoring forces between the at least one slip and the structure.

2. The anchoring and sealing device of claim **1**, wherein the anchoring and sealing device is a packer-type tool.

3. The anchoring and sealing device of claim **1**, wherein the tubular includes two frustoconical portions on opposing longitudinal ends of the tubular.

4. The anchoring and sealing device of claim **1**, wherein the seal includes the at least one seat.

5. The anchoring and sealing device of claim **1**, wherein the seal includes a non-polymeric portion and a polymeric portion.

6. The anchoring and sealing device of claim **1**, wherein the at least one slip and the seal are set in response to same longitudinally compressive forces being applied to the anchoring and sealing device.

7. The anchoring and sealing device of claim **1**, wherein the tubular includes the at least one seat.

8. The anchoring and sealing device of claim **1**, wherein the seal has a frustoconical portion in operable communication with the at least one slip.

9. The anchoring and sealing device of claim **8**, wherein the tubular has a frustoconical portion in operable communication with the seal.

10. An anchoring and sealing system comprising:

at least one slip;

a seal; and

a tubular in operable communication with the at least one slip and the seal the anchoring and sealing device being configured to cause radial movement of the at least one slip into anchoring engagement with a structure and to cause radial movement of the seal into sealing engagement with the structure in response to longitudinal compression of the anchoring and sealing device;

a setting tool configured to set the at least one slip into anchoring engagement with the structure and the seal into sealing engagement with the structure comprising:

a mandrel;

a collet slidably engaged with the mandrel between a first position and a second position, fingers of the collet being radially supported by the mandrel long as the collet is in the first position and unsupported radially as long as the collet is in the second position; and

a releasable member in operable communication with the mandrel and the collet configured to maintain the collet in the first position until forces greater than forces needed to set the at least one slip and the seal are attained.

11. The anchoring and sealing system of claim **10**, wherein the fingers are engagable with at least one of the at least one slip while being radially supported.

12. The anchoring and sealing system of claim **10**, wherein the at least one slip and the seal remain set after removal of the setting tool from the at least one slip and the seal.

13. The anchoring and sealing system of claim **10**, wherein the tubular, the at least one slip and the seal are all that remain anchored and sealed to the structure after removal of the setting tool from the tubular, the at least one slip and the seal.

14. The anchoring and sealing system of claim **10**, wherein the setting tool is configured to prevent inadvertent setting of the at least one slip or the seal during running of the anchoring and sealing system into the structure.

15. A setting tool comprising:

a mandrel;

a collet slidably engaged about the mandrel having radially deformable fingers that are prevented from radially deforming as long as the collet is in a first position relative to the mandrel and are allowed to radially deform as long as the collet is in a second position relative to the mandrel, the radially deformable fingers being engagable with a settable tool as long as the collet is in the first position and disengagable from the settable tool as long as the collet is in the second position; and

a release member releasably fixing the collet to the mandrel in the first position until release thereof, the release member being configured to release at loads greater than loads needed to set the settable tool.

16. The setting tool of claim **15**, wherein the collet and the mandrel are fully removable from the settable tool after having set the settable tool.

17. The setting tool of claim **15**, wherein ends of the mandrel engage with protrusions of the collet to distribute longitudinal loads in the radially deformable fingers through the mandrel instead of through the release member at least on one longitudinal direction.

18. The setting tool of claim **15**, wherein the settable tool is an anchoring and sealing device.

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